



A Prolonged Bite by a Western Whipsnake, *Hierophis viridiflavus carbonarius* (Bonaparte 1833) (Squamata: Colubridae), Resulting in Pronounced Local Edema

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Abstract.—Although extensive research has been conducted on snake venoms, the effects of bites inflicted by non-front-fanged colubroid snakes remain incompletely understood, particularly for species of uncertain medical relevance. The Western Whipsnake (*Hierophis viridiflavus*) is a colubrid snake typically classified as non-venomous and harmless to humans. Nevertheless, old works reporting the presence of Duvernoy’s glands in this species raise questions regarding its presumed lack of venom. This report presents the first case of a prolonged bite from a wild Western Whipsnake (*H. v. carbonarius*) that occurred in Italy, and provides a detailed account of the resulting effects. The primary symptom experienced by the bitten subject was painless, marked local edema, which subsided within 24 hours after the bite. The clinical manifestations observed in the current study suggest that *H. viridiflavus* could have the potential to inflict bites that lead to mild local effects consistent with envenoming.

Venomous snakes, all belonging to the clade Caenophidia (i.e., “advanced snakes”) are able to inject venom via specialized fangs or modified teeth (Vonk et al. 2008; Broeckhoven and du Plessis 2017). Species from the families Viperidae, Elapidae, and Atractaspididae use a high-pressure, front-fanged venom delivery system (Kerckamp et al. 2017). In these snakes, skeletal muscles compress the primary venom gland, propelling the venom through specialized hollow fangs that function like hypodermic needles (Jackson 2003; Young and Kardong 2007). Conversely, non-front-fanged colubroid (NFFC) snakes possess a low-pressure venom delivery system. In these snakes, venom is slowly released from the venom glands (commonly referred to as Duvernoy’s glands), which lack compressor muscles, near maxillary fangs that sometimes are enlarged and/or bear grooves through which venom flows into the bitten organism (Jackson 2003; Weinstein 2017).

Due to their venom delivery system’s structure and operation, NFFC snakes are generally unable to deliver significant amounts of venom to humans (Weinstein et al.

2013). However, a number of species (e.g., *Dispholidus typus*, *Philodryas olfersii*, *Rhabdophis tigrinus*, *Thelotornis capensis*) have been known to cause serious envenomations in humans, sometimes resulting in death (Kuch and Mebs 2002; Mackessy 2002; Prado-Franceschi and Hyslop 2002; Weinstein 2011). Nevertheless, NFFC snakes are typically considered of minor medical importance, and receive limited scientific attention (Jackson et al. 2019; Avella et al. 2022). Consequently, information regarding the threat most NFFC snake species pose to humans is largely lacking (Weinstein 2011).

The Western Whipsnake, *Hierophis viridiflavus* (Lacépède 1789), is a medium-sized colubrid with an average total length of approximately 150 cm (Schätti and Vanni 1986; Vanni and Zuffi 2011). Widely distributed across south-central Europe from northeastern Spain to coastal Croatia (Vogrin et al. 2009; Enciclopedia Virtual de los Vertebrados Españoles 2015), it occurs across the entire Italian peninsula as well as Sardinia and Sicily and several smaller islands and islets (Vanni and Nistri 2006; Avella et al. 2017; Di Nicola et

al. 2021a). Two different subspecies are currently recognized: *H. v. viridiflavus*, found in the western part of the species' distribution, typically has a black and yellow pattern of dots and stripes; and *H. v. carbonarius*, present in the eastern part of the species' range, is almost always completely or nearly completely melanistic (Di Nicola et al. 2021a, 2021b; Senczuk et al. 2021; Sindaco and Razzetti 2021; Storniolo et al. 2023).

Although typically considered highly defensive (Bea 1998), the Western Whipsnake is commonly regarded as non-venomous and essentially harmless to humans. Indeed, although (non-prolonged) bites by this species are common, they do not seem to cause any clinical manifestations other than minor mechanical trauma. Nonetheless, old studies (Phisalix 1922; Taub 1967) noted the presence of Duvernoy's glands in *H. v. viridiflavus*. Furthermore, a few reports (Bédry et al. 1998; Dutto et al. 2015) described the onset of symptoms consistent with envenomation of humans; however, these incidents often occurred in unusual circumstances, and the interpretations of the clinical progressions of the bitten subjects were questionable (Weinstein et al. 2023).

Herein we provide the first account of a prolonged bite by a wild *H. v. carbonarius* from northern Italy and describe

the occurrence of symptoms that exceeded those expected from proportional mechanical trauma alone.

Case Presentation

A 41-year-old man weighing 74 kg with no significant medical history, no known allergies, not currently taking any medications, and with no history of envenoming by any species of snake, was bitten by an adult *H. v. carbonarius* of unknown sex measuring approximately 125 cm in total length (Fig. 1). The incident occurred at approximately 1500 h during a hike through a semi-urbanised area characterized by sparse woodland with a few scattered pines in the hills around the city of Cesena in northern Italy (Fig. 1). The snake was caught in order to be used as a photographic subject.

While handling the snake, it inflicted a firm bite on the middle finger of the subject's right hand. The animal held on for about one minute, penetrating the skin with the teeth of the upper jaw, until efforts to manually remove it were successful. As soon as the animal's mouth disengaged from the bite site, a few small blood drops were evident at some of the wounds caused by the snake's teeth (Fig. 2). Roughly 30 minutes after the bite, the wounds were thoroughly cleaned

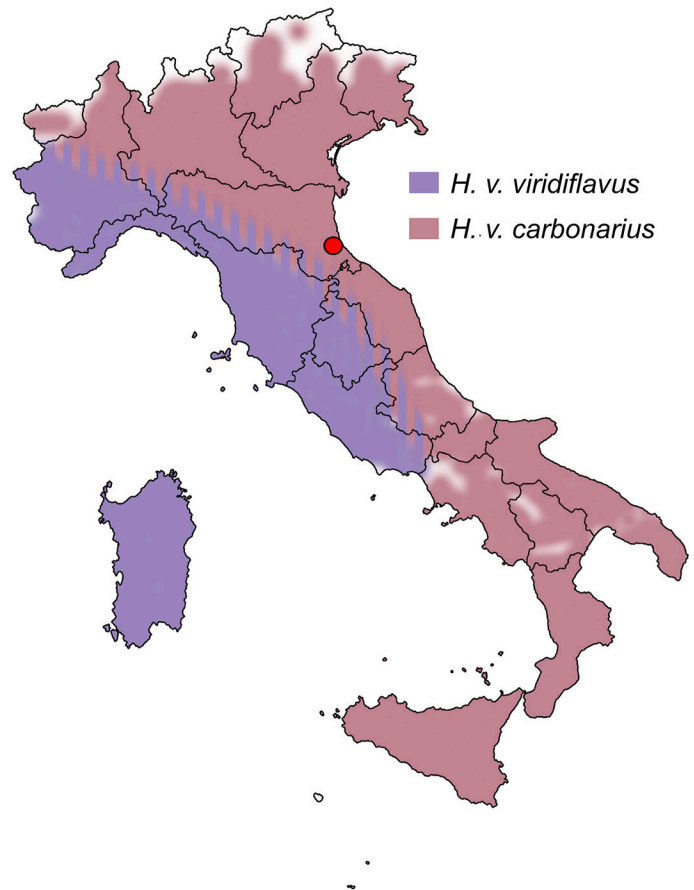


Figure 1. The Western Whipsnake (*Hierophis viridiflavus carbonarius*) that inflicted the bite described in the text (left). Map depicting the distribution of *H. v. viridiflavus* and *H. v. carbonarius* in Italy, with a red dot marking the area where the bite occurred (right). Map modified from Di Nicola et al. (2021a). Photograph by Fabio Savini.



Figure 2. Hand of the subject bitten by the Western Whipsnake (*Hierophis viridiflavus carbonarius*): Wounds caused by the snake's teeth at the bite site (left), pronounced edema involving the entire right hand of the bitten subject (center), and minor edema limited to the bite site at the end of the day following the bite (right). Photographs by Fabio Savini.

with clean water and soap, and no additional first aid measures were applied. On the day of the bite, the only symptom reported was paraesthesia (tingling and numbness) at the bite site. When awakening at 0800 h on the following day, the subject noticed pronounced edema involving his entire right hand (Fig. 2), with swelling sufficiently severe to prevent him from closing his hand but not associated with any pain or inflammation. At about 0900 h, concerned by the persistent symptoms and following the recommendations of the primary-care physician via teleconsultation, the subject took a 2-mg dose of betamethasone sodium phosphate (anti-inflammatory) and a 10-mg dose of cetirizine hydrochloride (antihistamine). No direct medical assessment of the bite wound and subject was performed, and no laboratory investigations were prescribed.

Approximately one hour after taking the medications, the symptoms started to subside. By the end of the day, only minor edema limited to the bite site remained noticeable (Fig. 2). All symptoms and clinical signs completely resolved by the end of the day following the bite. The subject continued taking betamethasone sodium phosphate 1 mg/day and cetirizine hydrochloride 1 mg/day for the next four days. No long-term effects or sequelae were reported. No follow-up formal medical examination was performed.

Discussion

This case represents the first report of a bite inflicted by a *H. viridiflavus* in Italy, and the first by the subspecies *H. v. carbonarius*. Traditionally considered homodontous (Dutto et al. 2015), the Western Whipsnake actually bears enlarged teeth in the rear of the maxilla that are less curved compared to other maxillary teeth (Racca et al. 2020). This dentary arrangement is similar to that seen in some NFFC snakes that use venom to subdue their prey (e.g., *Helicops angulatus*, *Hydrodynastes gigas*, *Spilotes sulphureus*) (Mackessy 2010;

Modahl et al. 2018; Westeen et al. 2020). Indeed, studies developed at the beginning of the 20th century found that the saliva produced by the Western Whipsnake was highly toxic to guinea pigs, reportedly causing neurotoxicity and often death even when injected in small quantities (Phisalix and Caius 1916). Nonetheless, data about the components of the saliva of *H. viridiflavus* exist and its biochemical properties remain unknown.

In line with the reported neurotoxicity observed in guinea pigs, one report of a prolonged bite inflicted by *H. viridiflavus* described the onset of transient neurotoxic symptomatology (Dutto et al. 2015). Nonetheless, emphasizing that the patient in the case in question presented a blood alcohol level of 2.1 g/L, indicating acute alcohol intoxication, is important — and complicates the assessment of potential neurotoxic effects from the prolonged snakebite. Consequently, the authors' claim that bites by *H. viridiflavus* can induce neurotoxic symptoms is inadequate (Weinstein et al. 2023).

The clinical manifestations observed following the snakebite described herein were only mild and local, primarily including pronounced edema, and none was consistent with neurotoxicity. Although conceivable that the observed symptoms (particularly the pronounced local edema) could have been intensified by the bitten individual's possible hypersensitivity, that he had no documented allergies and had never previously experienced envenomation from any snake species is important to note. Therefore, we are hesitant to attribute the observed symptoms in this case to the subject's hypersensitivity.

Although no apparent more severe or systemic symptoms were observed, their presence cannot be excluded. These symptoms would typically be revealed through laboratory analyses, which were not conducted in this case. The delayed and non-presential medical evaluation along with the absence of follow-up also represent limitations of the pres-

ent report. Indeed, a thorough and proper medical examination complemented by basic laboratory analyses could have provided crucial insights into the possible existence of undetected systemic effects and confirmed whether the observed symptoms were venom-induced. Important to note is that *H. viridiflavus* is commonly regarded as non-venomous and generally harmless, with most reported bites resulting in localized and relatively uncomplicated effects (Weinstein et al. 2023). Also noteworthy is that the bitten individual was a healthy adult male with an unremarkable medical history with no evidence of hypersensitivity. Therefore, that the mild symptoms were mostly overlooked by both the bitten individual and the attending physician is understandable.

One of the primary reasons most NFFC snakes receive limited attention by researchers and physicians is the lack of available information regarding the medical significance of most bites, the toxicity of the saliva (i.e., venom), and any symptoms caused in humans (Weinstein 2011). This paucity of knowledge has led to many NFFC snakes being classified as having no medical importance. Nevertheless, case reports of clinical manifestations occurring after bites of snakes traditionally considered harmless to humans are contributing useful information to the slowly growing literature on the medical relevance of several NFFC snakes. In this context, our report represents an initial step in investigating the potential threat posed by a *H. viridiflavus* snakebite. Indeed, considering the symptoms outlined in this report, we cannot rule out the possibility that some bites by *H. viridiflavus* could result in local envenoming.

This report represents the first documented case of a prolonged bite by a wild Western Whipsnake (*H. v. carbonarius*) resulting in pronounced local edema that persisted for approximately one day and raising questions about the possibility that *H. viridiflavus* bites could cause at least mild effects consistent with envenoming. While the lack of laboratory analyses and medical follow-up constitute limitations, this report highlights the importance of investigating snakes traditionally considered non-venomous and harmless to humans. Proteomic studies of *H. viridiflavus* aimed at identifying components of its saliva and secretions of its Duvernoy's glands would provide valuable information regarding the biochemical potential of *H. viridiflavus* and its classification as “non-venomous.”

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